The characteristics of hundred-mm cylindrical anode layer Hall plasma accelerator by experiments and three-dimensional particle in cell numerical investigation

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Abstract

The experimental and numerical studies are performed to investigate the hundred-mm cylindrical anode layer hall plasma accelerator with an outlet diameter of 150 mm. The Hall plasma accelerator can work at high power level (more than 3 kW) with a wide voltage rage of 300 – 2000 V and at two different modes: parallel-beam and focus-beam mode. The focused ion beam is found in the experiments with a full-width at half-maximum (FWHM) diameter of _˜160 mm at higher pressure (0.08 Pa) and _˜40 mm at lower pressure (0.03 Pa). Numerical investigation based on the three-dimensional particle-in-cell method is performed to study the ion dynamics and elucidate the origin of the ion beam characteristics. The simulation results reveal that the equipotential lines play an important role in the surface near the anode emitting the ions. The ion emitting surface is determined by the magnetic field lines near the anode and the magnetic mirror contributes to the focused beam significantly. At higher pressure 0.06 Pa, the simulation results show breathing oscillations in the discharge of the Hall plasma accelerator. Different from the traditional breathing mode in circular Hall plasma accelerator the bulk plasma oscillation in the simulation is trigged by the potential barrier which is higher than anode voltage and generated by the focused ion beam. The electric field near the anode is suppressed by potential barrier, falls down and causes a decrease in electron density by 47%. The discharge restores to normal level after the focused beam explodes and then the discharge complete a cycle in the purely electro-driven breathing oscillation. The breathing mode in simulation has a frequency _˜167 kHz – _˜250 kHz in our simulation and decreases with increasing voltage.

Keywords: ion beam, breathing mode, Hall plasma accelerator, particle, in, cell simulation

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